Section 11
Infrastructure Requirements for the Wastewater Collection System

The wastewater collection system in the study area was analyzed to determine its capacity to handle the flows of wastewater currently generated, as well as those projected for future conditions. The analysis attempts to identify the segments of pipelines with deficiencies and calculate the diameter of the pipelines to be replaced. Additionally, the model will be utilized to estimate the infrastructure requirements for the sanitary wastewater collection improvements for each alternative.

The wastewater collection system in Tijuana and Playas de Rosarito encompasses 2,657 km of pipelines, ranging in diameters from 10 to 252 cm. The system covers an area of 15,362 hectares and is divided into four sectors that discharge into two wastewater treatment plants through seven pumping stations. Section 3 provides a more detailed description of the system.

The modeling for the primary system considered pipelines with diameters between 30 and 183 cm. The total pipeline alignment lengths are 228,382 m and 4,487 m for Tijuana and Playas de Rosarito, respectively. The pipelines that were utilized in the model are shown in Figure 11-1.

11.1 Development of the Model

The wastewater collection systems in Tijuana and Playas de Rosarito are relatively very complex, mainly due to the irregular topography and its cumbersome configuration, as a result of the accelerated growth of the metropolitan area. Due to this complexity, the modeling of the system was made using a computer program specifically designed to address these issues.

The program that was utilized for the hydraulic simulation is H2OMAP Sewer. This program was selected from among several other options after its advantages and disadvantages were considered and weighed against the other programs. Its main characteristics are the following:

- Capability to simulate up to 2,000 pipeline sections
- Capability to simulate the system under dynamic and static flow conditions
- Capability to model systems with pumping stations with constant or variable flows (using the pump curves)
- Ability to calculate construction costs for new pipelines, provided a cost curve database is integrated into the program

- It suggests the diameters that should be used, in case the existing pipelines are undersized for their intended purpose, relative to their flow capacity and slope, for both the replacement of pipelines or the construction of parallel lines
- It functions with both English and Metric Systems
- It displays the profile and hydraulic gradient of the pipelines
- The modeling can be run utilizing the Hazen & Williams or Manning's equations
- It is compatible with programs such as ARCVIEW and AUTOCAD to export information
- Feeding information is simple and results are easy to understand
- It is relatively simple to operate and user friendly

The simulation of the system was only made for static conditions, since there is no detailed data concerning actual flows required for simulating the system under dynamic conditions. The type of information that is missing includes flow data in different points of the system during rainy and dry seasons. These flows would need to be measured 24 hours a day in short intervals to determine the curve of flow rates in the system. The procedure used to enter information into the model is as follows:

1. The wastewater collection system is laid out within a graphics environment using a graphic and numerical information structure containing the characteristics of the elements that compose the system.

2. Information is assigned to each one of these elements, including diameters, invert elevations, and manhole grade elevations, as well as flow rate measurements and pumping data. Information on wastewater flows and infiltration is also included.

3. As a complement, the user feeds the information that is not defined by the system graphic representation, such as pipeline diameters, grade elevation, invert elevations, and roughness coefficient, as well as maximum and minimum velocity limits.

4. Based on digitized information as indicated above, the program is used to obtain numeric data that shall be used in the hydraulic simulation. This information is transferred to files with a predetermined structure, to be used later in the hydraulic simulation.

5. The hydraulic simulation is performed. Its results consist of the values of the accumulated flow, velocity and the critical depth in the pipelines for different operating conditions.

Upon completion of the simulation process the modeler reviews the results based on the established design criteria. (See Table 11-1).

It is relevant to note that there are some differences between the design practices used by the program and those used in Mexico, regulated by Mexican norms and according to technical requirements set forth by Mexico's National Water Commission (CNA) and the State of Baja California.

For example, a common practice in Mexico is to use Harmon's coefficient to calculate peak factors in the wastewater collection system, based on the cumulative population upstream of the pipe segment, with the average cumulative flow up to this point. On the other hand, the model uses the average flow entered in each node and the population served by that node. This implies that all sections analyzed by the model will have slightly larger flows than those obtained when utilizing criteria generally used in Mexico.

Table 11-1
Design and Evaluation Criteria for the Wastewater Collection System

Element	Design Flow	Design Criteria	Formula
Sub-secondary sewers and secondary sewers.	Maximum expected flow (Qmaxext)	Largest minimum velocity equal to 0.3 m/s Maximum vel.5 m/s or that recommended by the supplier	Qmedd= Population*Contribution/86400Qmáxinst = M*Qmedd M= Hammon Coefficient =1+[14/(4+P^(1/2))] v=(1/n)(r^2/3)(s^1/2); v= average speed Q expected= 1.2*Qmaxinst according to SAHOPE norm
Minimum diameter (it refers to the minimum diameter to be used for designing pipelines, even if the theoretical flow is smaller)	Expected maximum flow (Qmaxext)	20 cm (8")	
Minimum flow (it refers to the minimum flow to be used when designing pipelines, even if the theoretical flow is smaller)	Maximum expected flow (Qmaxext)	Qmin=Qmed/2 Qmin for design = 1.5 l/s	
Maximum distance between manholes	Maximum expected flow (Qmaxext)	Up to 125 m for pipeline 8" to 24". From 27" to 40" 150 m, from 60" to 96" 175 m.	
Common manholes	Maximum expected flow	Pipeline with a diameter up to 61 cm (24") Inside diameter of the manhole = 1.20M	
Special manholes	Maximum expected flow (Qmáxext)	Pipeline larger than 61 cm (24").	
Small pumping station, civil work	Average daily flow (Qmedd)	A retention time of not more than 10 min. is established	
Small pumping station, electro mechanic	Maximum expected flow (Qmáxext)		

Table 11-1
Design and Evaluation Criteria for the Wastewater Collection System

Element	Design Flow	Design Criteria	Formula
Pressure line	Maximum expected flow (Qmáxext)	Minimum max velocity or equal to 0.3 m/s Maximum vel. 5 m/s or that recommended by the supplier.	Hazen - Williams:
Depth(d) to diameter (D) ratio	Maximum expected flow (Qmáxext)	80 % of interior diameter	D/d; d= Depth; D= Pipeline diameter.
Source: SAHOPE 1997, Technical regulations for Baja California			

The following is a summary of the required data for using the H2OMAP Sewer computer program:

a. Data on the sections

ID (Char)	From_INV (Num)	To_INV (Num)	Length (Num)	Diameter (Num)	COEFF (Num)
Identifier	Measure of Initial Invert	Measure of Final Invert	Length	Diameter	Roughness Coefficient

b. Data on inspection wells

ID (Char)	Diameter (Num)	Rim_Elev (Num)	Load 1 (Num)	Type1 (Num)	Coverage 1 (Num)
Identifier	Diameter	Grade	Flow rate	Type of structure	Populations

c. Data of the System Plan, with manholes , pipelines and location of pumping and outfall points.

d. Data on the wastewater flow per capita (l / pers / day) per manhole.

e. Elevations data and other information of outfall structures.

Once the pipelines subject to analysis have been defined, their areas of influence are defined according to wastewatershed, to determine flow rates for each node. The blue prints for the sewage laterals were used as the basis for defining these zones, and which were complemented with topographic maps from INEGI.

Available information on the operations of the system, such as critical depths, flow rates measured at manholes and pumping stations is used to calibrate the model. These data are used to determine whether the model is simulating the system's actual field conditions. The calibration process is discussed later.

11.2 Model Calibration

Once the model has been calibrated, it can be utilized to identify deficiencies that prevent the system from handling present and projected future flows. Based on these results, improvements can be proposed.

Wastewater collection system data up to the year 2001 was used for calibrating the model and two hydraulic simulations were performed using Manning's formula and a friction coefficient of 10 for PVC pipelines, and of 12 for reinforced concrete.

The first simulation was performed using the average daily flow, and the second one using the maximum expected flow (equivalent to the maximum peak flow). This last flow represents the worst possible conditions of the system and it reflects the maximum working condition of the latter.

The first simulation was performed to compare the results of the model with available information for pumping stations where flows are measured, as well as with other metering points in secondary sewers that discharge in open air, as shown in Figure 11-1 and Table 11-2.

Table 11-2
Flows Measured in Pumping Stations (in l/s; year 2001)

Month	PB1	PB3	PB Playas	PB Laureles	INV	Small pumping station Mirador 1	Lázaro Cárdenas	SBIWTP	Rosarito	Tecolote - La Gloria
January	658	152	86	13	35	10	1.00	1,087	35	25
February	799	178	87	17	36	9	1.50	1,080	33	25
March	635	155	81	16	32	9	1.70	988	36	25
April	941	171	90	19	38	10	2.50	1,069	40	25
May	993	195	91	20	41	10	3.00	1,005	41	25
June	908	215	91	21	45	10	3.00	1,060	38	25
July	945	208	95	21	50	9	4.00	1,019	39	25
August	902	202	99	21	50	10	5.00	1,092	37	25
September	938	205	96	19	52	10	5.17	1,067	34	25
October	892	204	99	20	43	10	3.00	1,075	34	25
November	908	192	96	20	40	10	2.50	1,079	34	25
December	1,053	188	89	21	35	11	2.00	1,064	37	25
Average	**881**	**189**	**92**	**19**	**41**	**10**	**3**	**1,057**	**37**	**25**

Table 11-3 presents the results obtained from the wastewater collection system simulation under average daily flow conditions for the control points used in the calibration. Wastewater flows used for this simulation correspond to the population distribution presented in Section 6 for each basin in relation to water consumption per user type.

Table 11-3 Flow Comparison in Measuring Points for Calibration (in l/s)									
Concept	**PB1**	**PB3**	**PB Playas**	**PB Laureles**	**INV**	**Small Pumping Station Mirador 1**	**SBIWTP**	**Rosarito**	**Tecolote - La Gloria**
Measured average (physical)	881.0	189.0	92.0	19.0	41.0	10.0	1057.0	37.0	27.0
Model result	907.2	149.7	60.0	29.9	27.9	9.7	1056.2	37.6	31.2
Difference (measured – model)	26.2	-39.3	-32.0	10.9	-13.1	-0.3	-0.8	0.6	6.2
Difference %	3.0	-20.8	-34.8	57.2	-32.1	-3.2	-0.1	1.7	23.1

In this first run of the model, significant differences can be appreciated in some control points, such as Laureles pumping station with a 57 percent difference between the actual average flow and the model; as well as the pumping station Playas in Tijuana with a 35 percent difference between the two.

For those points where actual measured flows were larger than the model flows, the following aspects were reviewed:

- Service areas utilized to enter data in the model
- The wastewater generation factor in relation to water consumption of the users.
- Inflow and infiltration
- Possible existence of interconnections between watersheds

For example, the first pump station PB3 contribution area analysis used 79 percent population coverage, which corresponds to the average study area coverage; a factor of 85 percent of the potable water consumption as a contribution to wastewater, which is also equivalent to the average value used for the whole study area; plus wastewater generated by industry, commerce and governmental facilities located within that basin. The first analysis resulted in an accumulated flow of 149.7 l/s, which 21 percent less than the measured flow of 189 l/s. With the purpose of reducing the difference between the results of the model and the measured flow, the coverage of this basin was adjusted to 94 percent, based on CESPT's wastewater coverage maps, and the contribution percentage was slowly varied from 85 to 86.5 percent. With these new values the model resulted in a flow of 187.3 l/s, which has a less than 1 percent difference with measures value. This process was repeated for all the modeled basins.

After adjusting these variables, the differences between the model and the measurements from the control points decreased to less than 12 percent in all cases; and this value is acceptable for calibration. Table 11–4 shows the final comparison values for the control points, after the model was calibrated.

Table 11-4 Flow Comparison in Measurement Points after Calibration of the Model (in l/s)									
Concept	**PB1**	**PB3**	**PB Playas**	**PB Laureles**	**INV**	**Small pumping station Mirador 1**	**SBIWTP**	**Rosarito**	**Tecolote - La Gloria**
Measured average (actual)	881.0	189.0	92.0	19.0	41.0	10.0	1057.0	37.0	25.0
Results of model	881.1	187.3	88.9	21.4	41.8	10.7	1,057.1	36.2	30.0
Difference (measured-model)	0.1	-1.7	-3.1	2.4	0.8	0.7	0.1	-0.8	3.0
Difference %	0.0	-0.9	-3.4	12.4	1.9	7.4	0.0	-2.1	11.1

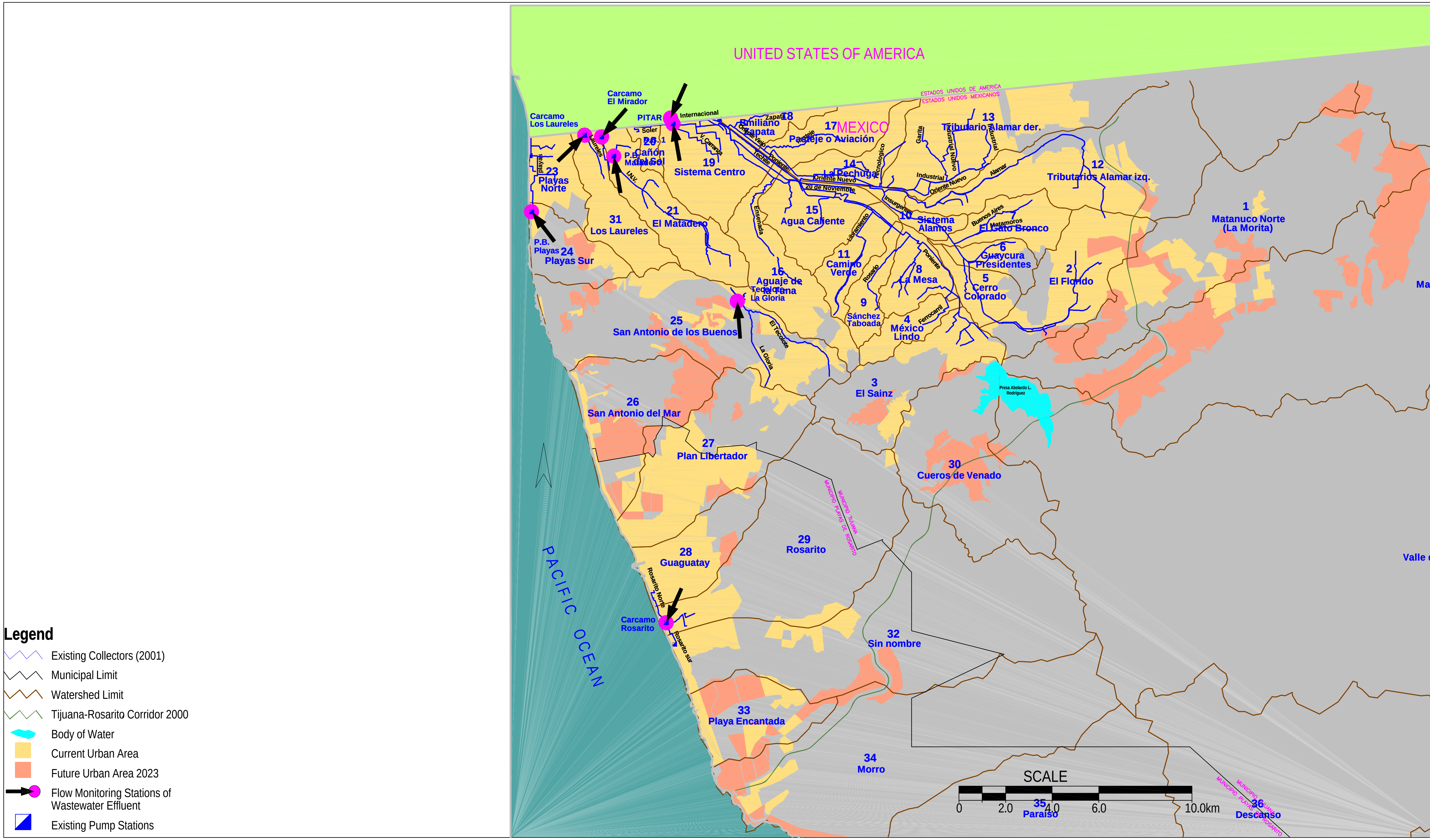


Figure 11-1
Flow monitoring stations of Wastewater Effluent

CDM

11.3 Operation of the System Under Current Conditions (Year 2001)

Once the model was calibrated, a simulation was performed under current conditions. The data that was used in the model is presented in Appendix Q.

Due to the uncertainty of some physical data, mainly in the sections where the survey records do not show any information about the monitoring wells (referred to as virtual points), some results obtained in the model runs do not reflect the actual operation of these sections, therefore it is necessary to know in greater detail the characteristics of the elements that make up the system, specially in the sections with positive slopes sections. It is also convenient to know the conditions of the pipeline in the virtual points, the actual influence zones, and the flows that go through the pipelines at strategic points and not only at discharge points.

The total analyzed length for Tijuana and Playas de Rosarito was 232,533 m of primary pipeline under current conditions. Table 11-5 shows total analyzed lengths.

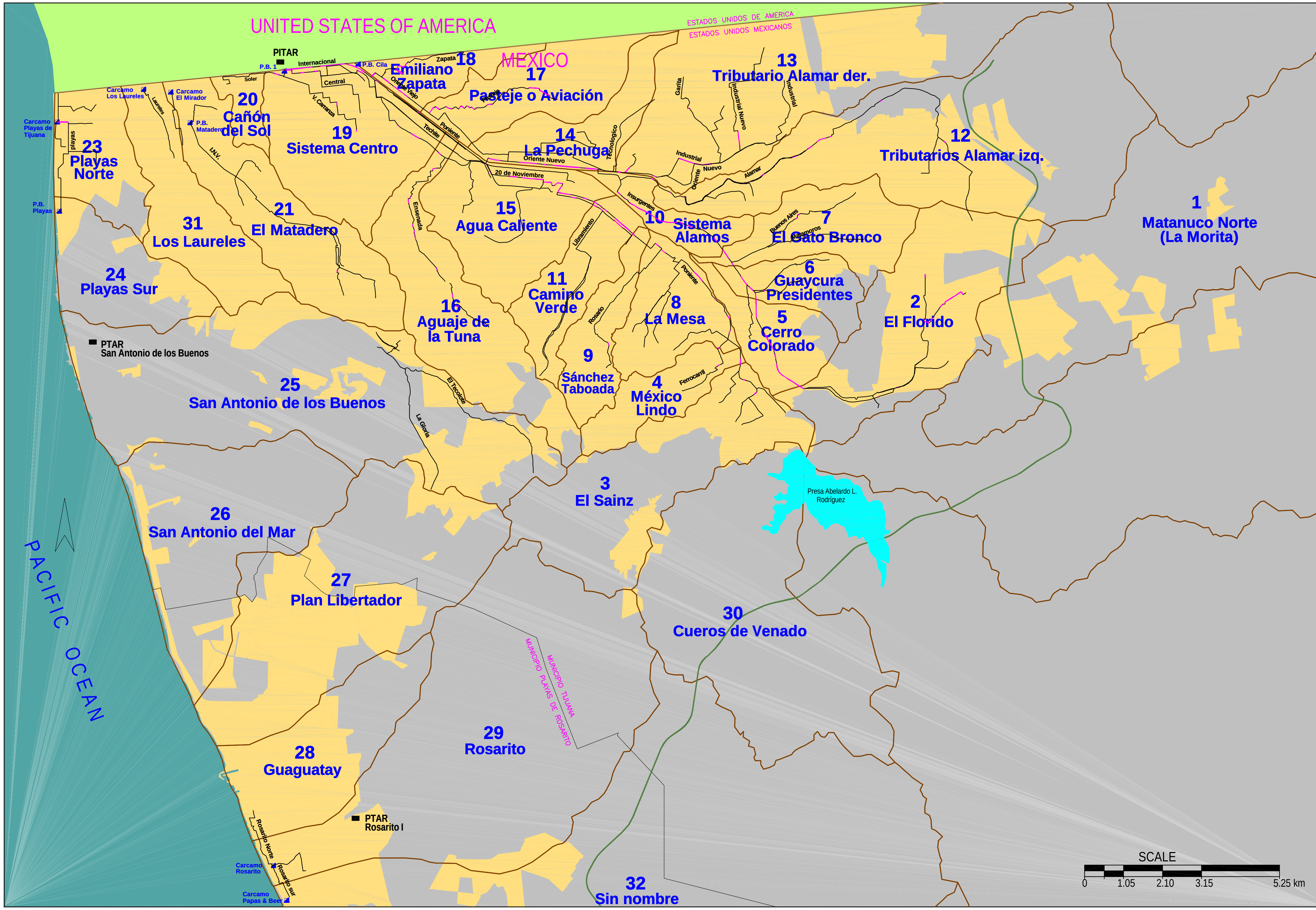
Table 11-5
Diameter and Length of Modeled Pipeline

Diameter (mm)	Length (m)
200	1,200
250	689
300	48,432
380	30,932
450	29,785
500	950
530	14,823
610	35,673
760	18,261
910	20,803
1,070	18,289
1220	4,542
1,520	793
1,830	7,362
Total	**232,533**

Simulation results with average daily flows show the existence of sections, with a total length of 1,085 m, that do have enough capacity to carry the flow generated upstream, which creates "overflow" of the pipeline and hydraulic head in the manholes upstream, which in turn cause some pipelines to operate under pressure. Diameters of pipeline segments with not enough capacity vary from 20 to 183 cm. The results of the hydraulic model runs are presented in Appendix Q, and these identify those pipeline sections. The secondary sewer segments with problems are Insurgentes, Oriente Nuevo, Ensenada, the Western interceptor and the International outfall.

The second simulation was performed under maximum expected flow, resulting in a larger number of sections with not enough capacity, with a total length of 33,370 m., representing close to 15 percent of the analyzed pipeline. Among the structures that present greater deficiencies are: The International outfall, Western Interceptor, Insurgentes collectors, INV Nuevo, Oriente Nuevo, Playas de Tijuana, Sánchez Taboada, Oriente Viejo, Ensenada, and sub-collectors Pastejé, Teotihuacan and Industrial. Appendix Q depicts pipeline sections with insufficient capacity under current conditions.

Figure 11-2 presents pipelines with capacity problems to convey projected maximum flows. The 1,085 m of pipelines with capacity problems to convey projected average flows, previously mentioned as part of the first simulation, will also present maximum flow conveyance problems.



Legend

- Collectors with capacity
- Collectors without capacity
- Municipal Limit
- Watershed Limit
- Tijuana-Rosarito Corridor 2000
- Body of Water
- Current Urban Area
- PTAR Wastewater Treatment Plant
- Pump Station

Figure 11-2
Existing segments with conveyance capacity problems (2001)

CDM

The modeling results under current conditions of the wastewater collection system indicate that 14.5 percent of the existing pipelines lack the capacity to carry the maximum expected peak flow, as this condition hinders the ability of hooking up new customers to the system in the short term. Appendix Q shows the location of each one of the sections that currently have capacity problems. Similarly, Section 12 indicates the diameter that should be used when rehabilitating them, or the parallel pipe diameter that should be used to handle the additional flow.

It is recommended for CESPT to physically check the sections with capacity problems to verify whether these sections have counter slope problems in the survey and if indeed in model as well.

11.4 Wastewater Collection Alternatives

The proposed alternatives for future conditions considered both the growth of the cities and the wastewater collection system infrastructure. The wastewater collection system was divided in several sectors assigned to existing and proposed treatment plants.

The modeling of the future sewer system and proposed alternatives was performed based on the systems' present conditions and short term proposed improvements.

When presenting alternatives, the optimization of the present system was sought, as well as the most adequate operating conditions. Section 12 shows the twelve alternatives for potable water and wastewater developed and evaluated as part of the master plan. Within these twelve global alternatives, there are four variations concerning the wastewater system, which were thoroughly evaluated. As part of this evaluation, the need for expansion and rehabilitation work will have been identified, as well as estimates of their implementation costs.

Table 11-6 shows proposed treatment plants for each one of the evaluated alternatives (B, C, D and E - wastewater), which will determine among other factors, wastewater collection systems requirements for each alternative.

Table 11-6
WWTP Capacity for each Alternative

Wastewater Treatment Plant	Alternative B-B, F-B, G-E	Alternative B-C, F-C, G-C	Alternative B-D, F-D, G-D	Alternative B-E, F-E, G-E
	Capacity (l/s)			
WWTP´s Base				
International Plant	1,100	1,100	1,100	1,100
San Antonio de los Buenos	1,100	1,100	1,100	1,100
Rosarito I	50	50	50	50
La Morita	380	380	380	380
Monte de los Olivos	460	460	460	460
Tecolote- La Gloria	380	380	380	380
Rosarito II	210	210	210	210

Table 11-6 WWTP Capacity for each Alternative				
Wastewater Treatment Plant	**Alternative B-B, F-B, G-E**	**Alternative B-C, F-C, G-C**	**Alternative B-D, F-D, G-D**	**Alternative B-E, F-E, G-E**
	Capacity (l/s)			
Proposed WWTPs				
Alamar - regional	1,470	1,090	-	980
La Morita extension	-	-	-	490
Coastal - regional basin	-	380	1,470	-
Rosarito I - expansion extension	70	70	70	70
Popotla	130	130	130	130
Mesa del Descanso	20	20	20	20
Puerto Nuevo	20	20	20	20
La Misión	10	10	10	10

The following is a brief description of each alternative, while the results of the hydraulic modeling are presented later.

Alternative B-B (Same as F-B and G-B)

In this alternative the conveyance of wastewater to 12 treatment plants is planned; 3 already exist and 9 are proposed. Four of those nine are part of the Japanese credit program, and the remaining five are proposed in this study. The location of each of these plants is presented in Figure 11-3.

Regional Alamar Plant

This plant is the one with the largest capacity and will receive wastewater from the secondary sewer system Insurgentes, Lamar and New East. The flow conveyed by these sewers will be received at a point where the three secondary sewer intercept, via a pumping station located on landmark 37 m above sea level., proposed at Chapultepec – Alamar subdivision, at the intersection of the following streets: Airport Road, Canal del Rio Tijuana and Canal Río Alamar. From this point the water will be conveyed to the proposed treatment plant to an approximate distance of 10.8 km and at about 86 m above sea level. Wastewater flows from the following sub basins will discharge to the plants: Matanuco Sur, Tributaries Alamar Right, Tributaries Alamar Left, Alamos Systems, Guaycura Presidentes, Gato Bronco and Cerro Colorado.

San Antonio de Los Buenos and SBIWTP

These plants will receive wastewater from the following sub basins: Cañón del Sol, Sistema Centro, Aguaje de la Tuna, Camino Verde, Sánchez Taboada, La Mesa, México Lindo, El Sainz, Cueros de Venado, Valle de las Palmas, Emiliano Zapata, Pastejé and la Pechuga. Approximately 70 percent of the flow generated in this area will be treated at the SBIWTP plant, and the rest will be pumped to the pumping station in San Antonio de los Buenos through PB1. This pumping incorporates wastewater coming from the following sub basins: El Matadero, Los Laureles, Playas North and Playas South.

Monte de los Olivos
This plant is part of the Japanese credit program, and will receive wastewater from El Florido sub basin.

Tecolote la Gloria
This plant is part of the Japanese credit program, and will receive wastewater from San Antonio de los Buenos and San Antonio del Mar sub basins.

La Morita
This plant is part of the Japanese credit program, and will treat 80 percent of the wastewater coming from Matanuco North sub basin. The rest of the wastewater generated in this basin will be conveyed to the Alamar regional WWTP.

Rosarito II
This plant is part of the Japanese credit program, and will receive wastewater from Plan Libertador sub basin.

Rosarito I
This plant will receive wastewater from Rosarito y Guaguatay sub basins.

Popotla
Will treat wastewater from the following sub basins; Sin Nombre, Playa Encantada and El Morro.

Puerto Nuevo
Will receive wastewater from the Paraiso sub basin.

Mesa del Descanso
Will treat wastewater from El Descanso and Mesa del Descanso sub basins.

La Misión
Will receive wastewater from La Misión sub basin

Figure 11-3 depicts the wastewater sheds for each one of the existing and proposed WWTPs for this alternative.

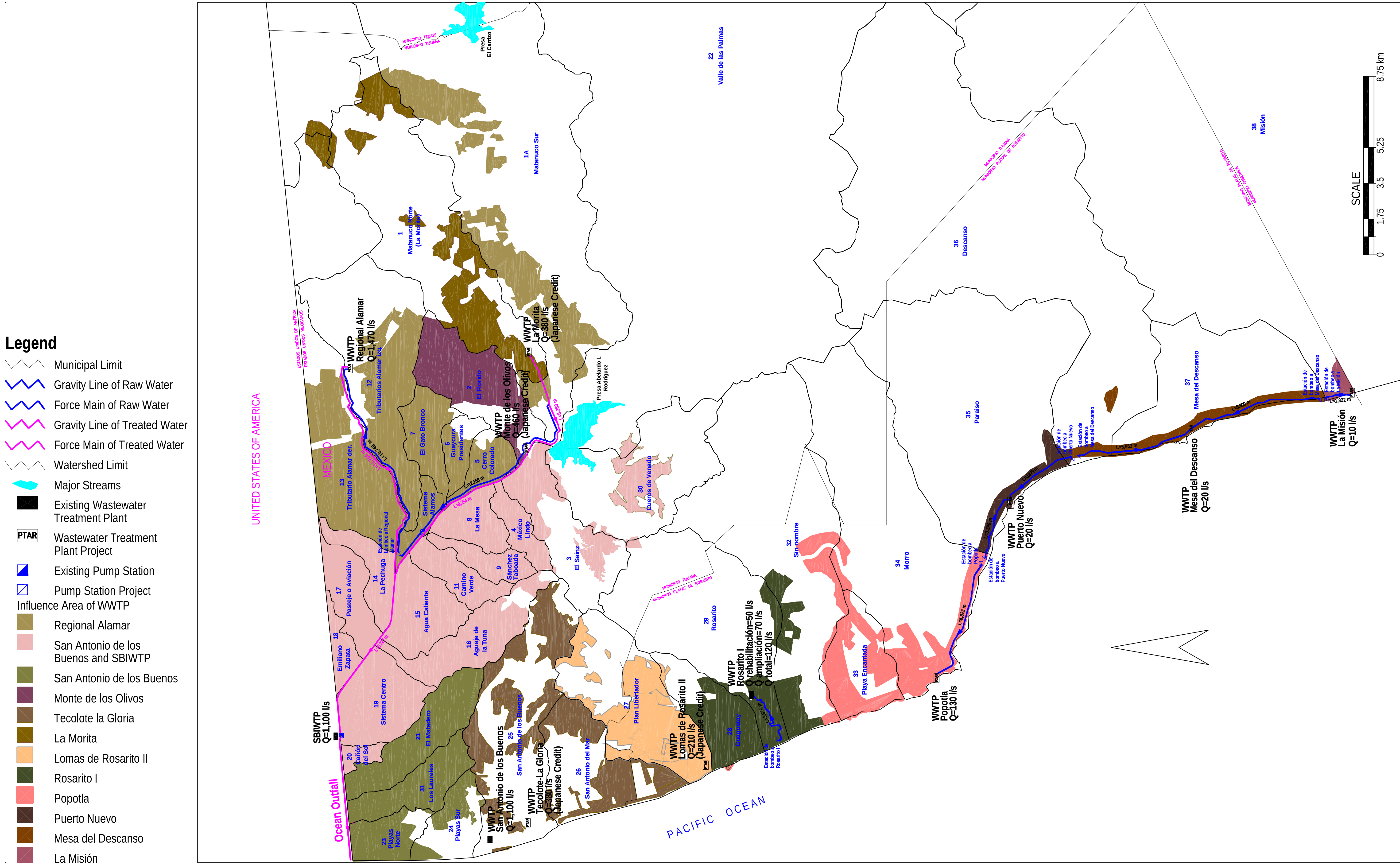


Figure 11-3
Areas of contribution for WWTP (Alternative BB)

Because of the plants' location and elevation, several conveyance lines will have to be built along with pumping stations to carry the water to the different plants. Table 11-7 shows the conveyance infrastructure.

Table 11-7
Proposed Infrastructure for Wastewater Pumping Stations
(Alternatives B-B, F-B, G-B)

Pumping Station	From	To	Flow		Pressure		HP at 70% Efficiency	
			l/s	gpm	m	feet	Needed	Proposed
Alamar Regional	Alamar pumping station	WWTP Alamar	3,175	50,325	84	275	6,344	6,400
Rosarito I	Pumping Station Rosarito	WWTP Rosarito I	151	2,393	66	216	237	250
Popotla	Pumping Station Popotla	WWTP Popotla	68	1,078	42	138	34	60
Mesa del Descanso	Pumping Station Mesa del Descanso	WWTP Mesa del Descanso	78	1,236	54	178	100	100
Puerto Nuevo	Pumping Station Puerto Nuevo	WWTP Puerto Nuevo	78	1,236	36	119	67	70
La Misión	Pumping Station La Misión	WWTP La Misión	21	333	14	47	7	10

Proposed infrastructure for Wastewater Conveyance Lines

Conveyance line	From	To	Diameter		Length		Flow	
			cm	in	m	Feet	l/s	gpm
Regional Alamar	Alamar Pumping Station	WWTP Alamar	122	48	10,749	35,243	3,175	50,325
Rosarito I	Pumping Station Rosarito	WWTP Rosarito I	36	14	3,676	12,052	151	2,393
Popotla	Pumping Station Popotla	WWTP Popotla	20	8	6,323	20,731	68	1,078
Mesa del Descanso	Pumping Station Mesa del Descanso	WWTP Mesa del Descanso	20	8	12,753	41,813	78	1,236
Puerto Nuevo	Pumping Station Puerto Nuevo	WWTP Puerto Nuevo	20	8	7,269	23,833	78	1,236
La Misión	Pumping Station La Misión	WWTP La Misión	20	8	1,322	4,334	21	333

Alternative B-C (Same as F-C and G-C)

This alternative proposes a wastewater treatment plant, referred to as Coastal Basin Regional, in addition to those proposed in Alternative l, and thus the Regional Alamar WWTP capacity is reduced.

Location of the Coastal basin plant is very close to the existing plant in San Antonio de los Buenos. The wastewatershed for each plant is defined as follows:

Plant in San Antonio de los Buenos, SBIWTP and Regional Coastal Plant

These WWTPs will receive wastewater from the following sub basins: Alamar Tributary Right, Cañón del Sol, Sistema Centro, Aguaje de la Tuna, Camino Verde, Sánchez Taboada, La Mesa, Mexico Lindo, El Sainz, Cueros de Venado, Valle de las Palmas, Emiliano Zapata, Pastejé and La Pechuga. 60 percent of the generated wastewater in these basins will be treated at the SBIWTP, while the rest will be pumped to the plant in San Antonio de los Buenos and the Coastal Regional, using the PB1 pumping station. This pumping station will also receive wastewater from the following sub basins: El Matadero, Los Laureles and Playas Norte. Playas Sur sub basin discharges at the Alamar Regional Plant.

Treatment plants at Monte de los Olivos, Tecolote La Gloria, La Morita, Rosarito I & II, Popotla, Puerto Nuevo, Mesa del Descanso and la Misión, will receive wastewater from the same contributing sub basins described in Alternative 1.

Figure 11-4 shows contributing areas for each treatment plant, according to the capacity proposed in this alternative.

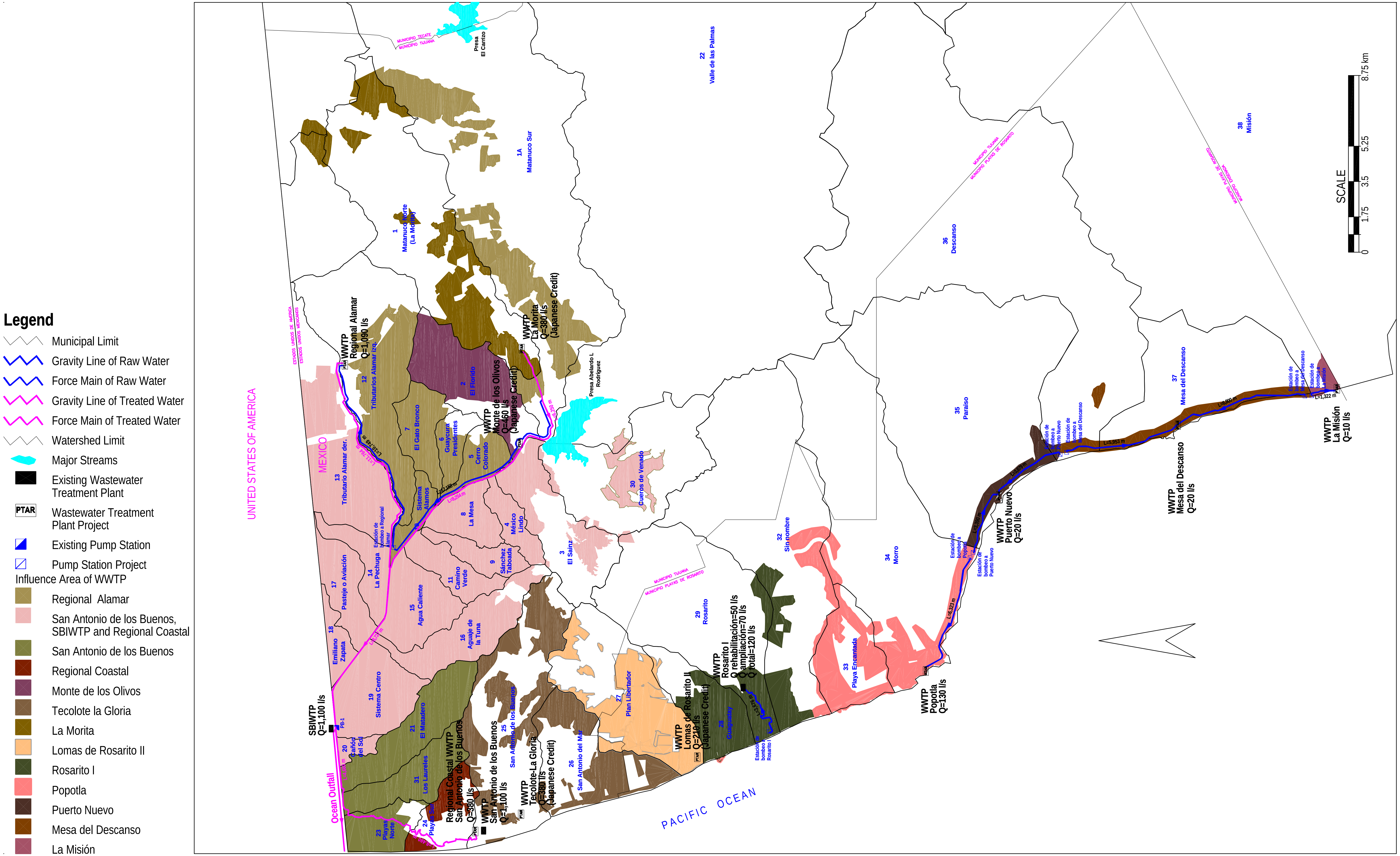


Figure 11-4
Areas of contribution for WWTP (Alternative BC)

Sewer lines and pumping stations that will convey wastewater to the different WWTPs are presented in Table 11-8.

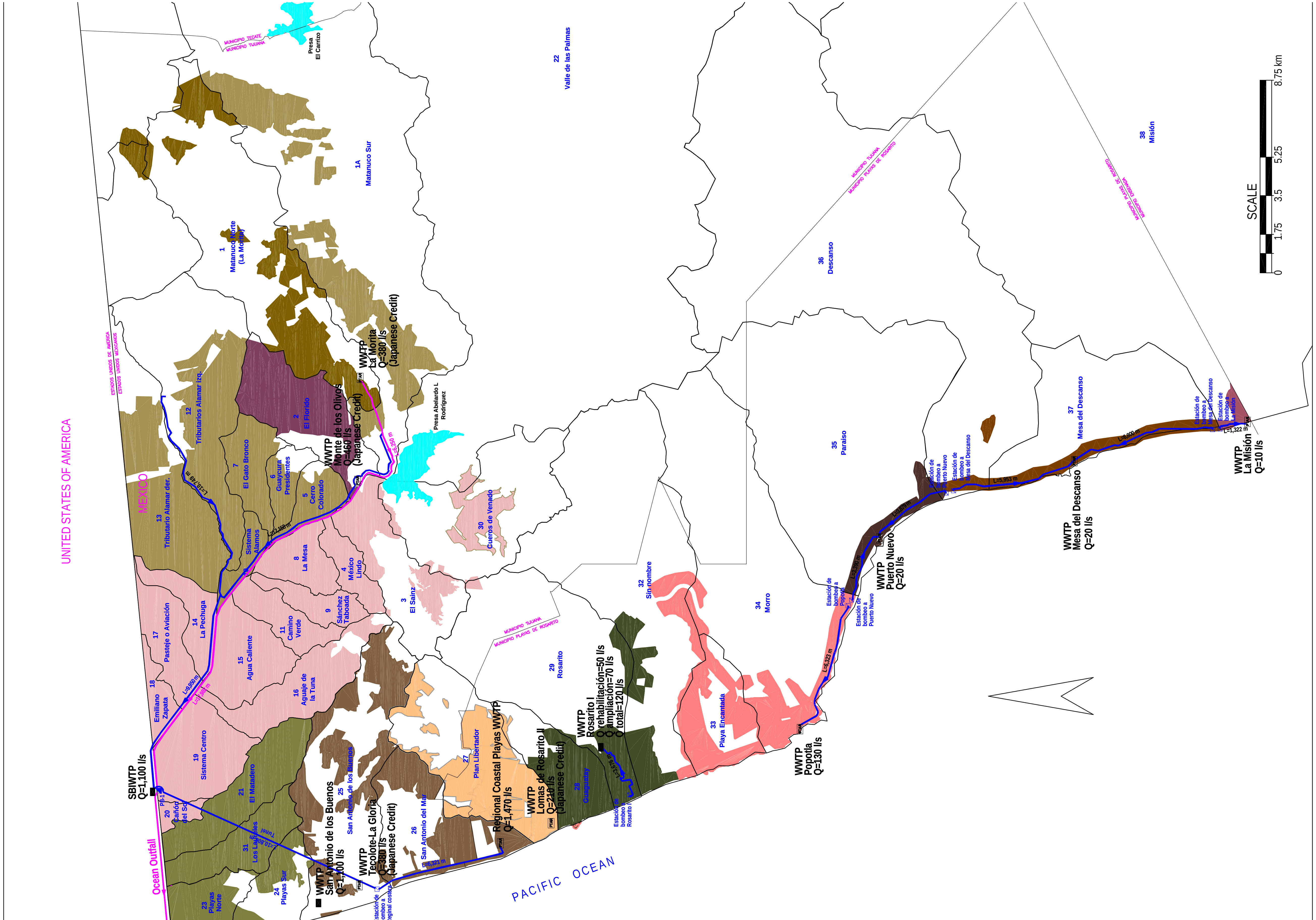
Table 11-8 Proposed Infrastructure for Wastewater Pumping Stations (Alternatives B-C, F-C, G-C)								
Pumping Station	**From**	**To**	**Flow**		**Pressure**		**HP at 70% Efficiency**	
			L/s	**gpm**	**m**	**feet**	**Needed**	**Proposed**
Alamar Regional	Pumping Station Alamar	WWTP Alamar	2,354	37,312	70	229	3,911	4,000
Regional Coastal Basin	Pumping Station PB-1N	WWTP Coastal Basin	821	13,013	145	476	2,838	2,900
Rosarito I	Pumping Station Rosarito	WWTP Rosarito I	151	2,393	66	216	237	250
Popotla	Pumping Station Popotla	WWTP Popotla	68	1,078	42	138	34	60
Mesa del Descanso	Pumping Station Mesa del Descanso	WWTP Mesa del Descanso	78	1,236	54	178	100	100
Puerto Nuevo	Pumping Station Puerto Nuevo	WWTP Puerto Nuevo	78	1,236	36	119	67	70
La Misión	Pumping Station La Misión	WWTP La Misión	21	333	14	47	7	10
Proposed Infrastructure for Wastewater Conveyance Pipelines								
Conveyance Pipeline	**From**	**To**	**Diameter**		**Length**		**Flow**	
			cm	**in**	**m**	**feet**	**l/s**	**gpm**
Regional Alamar	Pumping Station Alamar	WWTP Alamar	122	48	10,749	35,243	2,354	37,312
Coastal Basin Regional	Pumping Station PB-1N	WWTP Cuenca Costera	61	24	4,660	15,279	821	13,013
Rosarito I	Pumping Station Rosarito	WWTP Rosarito I	36	14	3,676	12,052	151	2,393
Popotla	Pumping Station Popotla	WWTP Popotla	20	8	6,323	20,731	68	1,078
Mesa del Descanso	Pumping Station Mesa del Descanso	WWTP Mesa del Descanso	20	8	12,753	41,813	78	1,236
Puerto Nuevo	Pumping Station Puerto Nuevo	WWTP Puerto Nuevo	20	8	7,269	23,833	78	1,236
La Misión	Pumping Station La Misión	WWTP La Misión	20	8	1,322	4,334	21	333

Alternative B-D (Same as F-D and G-D)

This alternative presents the same number of pumping stations and the same capacity as Alternative B–B, with the difference that Alamar Regional is substituted by the Coastal Basin Regional plant, located in the lower part of Plan Libertador sub basin. Under the proposed plan under this alternative, the majority of wastewater generated in the Rio Tijuana basin would continue to be taken out of the basin for subsequent treatment.

Wastewatersheds each plant are the same as in Alternative B-B, but the wastewater collected in the Río Tijuana basin will be conveyed to the Coastal Basin Regional. This plant will receive wastewater from the following secondary sewers: Insurgentes, Alamar and Oriente Nuevo. The flow of these secondary sewers will be captured at the point where the three intercept and conveyed by gravity to PB1. From this point, wastewater will be conveyed through a tunnel to the San Antonio de los Buenos WWTP discharge site. From there it will be pumped to the proposed site for the Coastal Basin Regional. Sub basins associated with this plant are: Matanuco Sur, Alamar Tributaries Right, Alamar Tributaries Left, Sistema Álamos, Guaycura Presidentes, Gato Bronco and Cerro Colorado.

The rest of the proposed plants have the same wastewatersheds as described in Alternative B–B. Figure 11–5 shows the wastewatersheds for each WWTP.



Legend

- Municipal Limit
- Gravity Line of Raw Water
- Force Main of Raw Water
- Gravity Line of Treated Water
- Force Main of Treated Water
- Watershed Limit
- Major Streams
- Existing Wastewater Treatment Plant
- PTAR Wastewater Treatment Plant Project
- Existing Pump Station
- Pump Station Project

Influence Area of WWTP

- Regional Coastal Playas
- San Antonio de los Buenos and SBIWTP
- San Antonio de los Buenos
- Monte de los Olivos
- Tecolote la Gloria
- La Morita
- Lomas de Rosarito II
- Rosarito I
- Popotla
- Puerto Nuevo
- Mesa del Descanso
- La Misión

Figure 11-5
Areas of contribution for WWTP (Alternative BD)

Table 11-9 shows the conveyance infrastructure proposed for this alternative.

Table 11-9
Proposed Infrastructure for Wastewater Pump Stations
(Alternatives B-D, F-D, G-D)

Pumping Station	From	To	Flow		Pressure		HP at 70% Efficiency	
			l/s	gpm	m	feet	Needed	Proposed
Coastal Basin Regional Playas	Pump Station Coastal Basin	WWTP Coastal Basin Rosarito	3,175	50,325	57	186	4,280	4,400
Rosarito I	Pump Station Rosarito	WWTP Rosarito I	151	2,393	66	216	237	250
Popotla	Pump Station Popotla	WWTP Popotla	68	1,078	42	138	34	60
Mesa del Descanso	Pump Station Mesa del Descanso	WWTP Mesa del Descanso	78	1,236	54	178	100	100
Puerto Nuevo	Pump Station Puerto Nuevo	WWTP Puerto Nuevo	78	1,236	36	119	67	70
La Misión	Pump Station La Misión	WWTP La Misión	21	333	14	47	7	10

Proposed Infrastructure for Wastewater Conveyance Pipelines

Conveyance Pipelines	From	To	Diameter		Length		Flow	
			Cm	in	m	feet	l/s	Gpm
Coastal Basin Regional Playas	Pump Station Coastal Basin	WWTP Coastal Basin Rosarito	142	56	6,321	20,725	3,175	50,325
Rosarito I	Pump Station Rosarito	WWTP Rosarito I	36	14	3,676	12,052	151	2,393
Popotla	Pump Station Popotla	WWTP Popotla	20	8	6,323	20,731	68	1,078
Mesa del Descanso	Pump Station Mesa del Descanso	WWTP Mesa del Descanso	20	8	12,753	41,813	78	1,236
Puerto Nuevo	Pump Station Puerto Nuevo	WWTP Puerto Nuevo	20	8	7,269	23,833	78	1,236
La Misión	Pump Station La Misión	WWTP La Misión	20	8	1,322	4,334	21	333

Alternative B-E (Same as F-E and G-E)

This alternative proposes the same number and location of WWTP's as Alternative B–B, with the difference that the capacity of Alamar Regional will be reduced, while the plant at La Morita will be expanded. Figure 11-6 shows the location of these plants.

Alamar Regional

This plant will receive wastewater form the following secondary sewers: Insurgentes, Alamar and Oriente Nuevo. The flow of these secondary sewers will be captured at the point where the three intercept and using a pump station located at 37 m.o.s.l., will be elevated to 86 m.o.s.l., at approximately 10.8 km. Contributing sub – basins that will supply this plant are:

Alamar Tributarios Right, Alamar Tributaries Left, Sistema Álamos, Guaycura Presidentes, Gato Bronco and Cerro Colorado.

La Morita

This plant will be built for a capacity of 380 l/s in its first stage and will be expanded on a median term to 870 l/s. Wastewater treated in this plant will come from Matanuco sub - basin (North and South).

The sewersheds for the other plants are identical to those described for Alternative 1, as shown in Figure 11-6.

Table 11-10 summarizes the wastewater conveyance infrastructure proposed as part of Alternatives B-E, F-E and G-E.

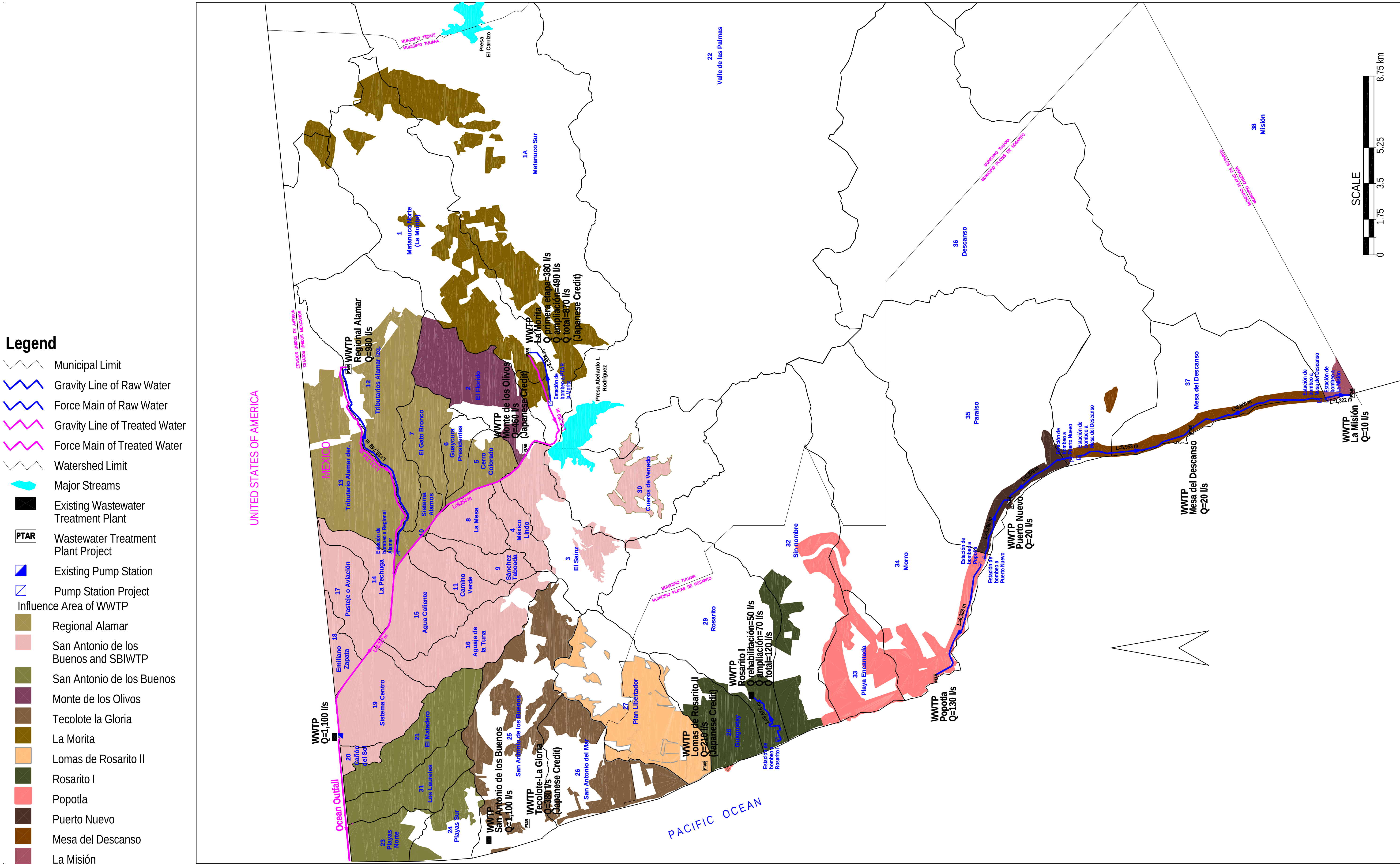


Figure 11-6
Areas of contribution for WWTP (Alternative BE)

Proposed infrastructure for wastewater conveyance for Alternatives B-E, F-E, and G-E is shown in Table 11-10.

Table 11-10
Proposed Infrastructure for Wastewater Pump Stations
(Alternatives B-E, F-E, G-E)

Pump Station	From	To	Flow		Pressure		HP at 70% Efficiency	
			l/s	gpm	m	feet	Needed	Proposed
Regional Alamar	Pump Station Alamar	WWTP Alamar	2,117	33,555	10,749	35,243	3,350	3,400
Expansion La Morita	Pump Station La Morita	WWTP Expansion La Morita	1,058	16,770	2,914	9,554	885	900
Rosarito I	Pump Station Rosarito	WWTP Rosarito I	151	2,393	66	216	237	250
Popotla	Pump Station Popotla	WWTP Popotla	68	1,078	42	138	34	60
Mesa del Descanso	Pump Station Mesa del Descanso	WWTP Mesa del Descanso	78	1,236	54	178	100	100
Puerto Nuevo	Pump Station Puerto Nuevo	WWTP Puerto Nuevo	78	1,236	36	119	67	70
La Misión	Pump Station La Misión	WWTP La Misión	21	333	14	47	7	10
Proposed Infrastructure for Wastewater Conveyance Pipelines								
Conveyance Pipeline	**From**	**To**	**Diameter**		**Length**		**Flow**	
			cm	**in**	**m**	**feet**	**l/s**	**gpm**
Regional Alamar	Pump Station Alamar	WWTP Alamar	122	49	10,749	35,243	2,117	33,555
Expansion La Morita	Pump Station La Morita	WWTP Expansion La Morita	76	30	2,914	9,554	1,058	16,770
Rosarito I	Pump Station Rosarito	WWTP Rosarito I	36	14	3,676	12,052	151	2,393
Popotla	Pump Station Popotla	WWTP Popotla	20	8	6,323	20,731	68	1,078
Mesa del Descanso	Pump Station Mesa del Descanso	WWTP Mesa del Descanso	20	8	12,753	41,813	78	1,236
Puerto Nuevo	Pump Station Puerto Nuevo	WWTP Puerto Nuevo	20	8	7,269	23,833	78	1,236
La Misión	Pump Station La Misión	WWTP La Misión	20	8	1,322	4,334	21	333

11.5 Wastewater Collection System Analysis in relation to the location of WWTP's for each Alternative

The wastewater collection system was modeled for each one of the four alternatives to identify the construction and rehabilitation work needed to collect wastewater and convey it to the WWTP's recommended by each alternative.

Results of hydraulic analysis for each alternative are shown in Appendix Q. As it can easily be observed, the needed pipeline lengths to convey wastewater are very similar

The main differences between alternatives correspond to the pipelines to convey wastewater from concentration points (pump stations) to treatment plants.

The results of Alternatives B-B and B-D modeling are very similar and the main difference is the pressure lines previously described in the presentation of each alternative.

Alternative B-C differs from B-B, because 380 l/s will not enter Alamar Regional Plant; instead they will be conveyed to the Eastern secondary sewage toward PB1 and from there, to Coastal Basin regional. The diameter of this secondary sewage will be the same as all other alternatives.

The main difference between Alternative B-E and Alternative B-B is due to the expansion of La Morita plant, which reduces the need to convey wastewater below this point for 490 l/s. This implies that the diameters of the gravity lines for the proposed pump station to capture wastewater at Matanuco Sur until the intersection with the pump station for Alamar Regional, will be smaller that in the other alternatives.

Table 11-11 shows the lengths of sewage pipelines to be rehabilitated and the necessary pipelines for each one of the alternatives.

Table 11-11
Length of Pipelines to be Rehabilitated according to each Alternative

Diameter		(Alternative B-B)		(Alternative B-C)		(Alternative B-D)		(Alternative B-E)	
		Rehabilitation	New	Rehabilitation	New	Rehabilitation	New	Rehabilitation	New
inch	mm	m	m	m	m	m	m	m	m
8	200	19	2,027	19	2,027	19	2,027	19	2,027
10	250	1,002	0	1,002	0	1,002	0	1,002	0
12	300	1,995	8,555	1,995	8,555	1,995	8,555	1,995	11,045
14	356	3,385	0	3,385	0	3,385	0	3,385	0
15	380	959	67,265	959	67,265	959	67,265	959	67,181
16	406	2,570	0	2,570	0	2,570	0	2,602	0
18	450	2,635	10,523	2,635	10,523	2,635	10,523	2,700	10,523
20	500	3,499	8,319	3,499	8,319	3,499	8,319	3,424	8,319
24	610	6,697	24,722	6,697	24,722	6,697	24,722	6,697	24,866
30	760	4,216	16,367	4,216	16,367	4,216	16,367	5,385	16,367
36	910	6,263	23,448	6,125	23,448	4,545	23,448	5,718	20,958
42	1,070	1,931	6,262	2,068	6,262	2,664	6,262	3,408	9,527
48	1,220	3,306	3,265	2,781	3,265	3,393	3,265	2,613	1,749
55	1,400	1,854	0	2,941	0	1,437	0	2,509	0
60	1,520	1,791	1,792	1,495	1,792	1,785	1,792	2,699	43
72	1,830	3,144	0	3,351	0	4,080	0	2,378	0
84	2,130	1,788	0	1,985	0	2,067	0	1,202	0
96	2,440	1,957	0	1,516	0	1,600	0	1,080	0
100	2,500	426	0	426	0	605	0	106	0
Total		**49,436**	**172,544**	**49,666**	**172,544**	**49,151**	**172,544**	**49,881**	**172,603**

Pipeline diameters and lengths shown in Table 11-11 show the amount of pipeline that has to be built parallel to the existent pipeline to achieve the conveyance capacity needed to satisfy future conditions in the "new" column.

Results from the modeling of the network in conditions of maximum flow expected for the year 2023 will be used to calculate costs. Section 12 shows methodology to calculate costs for each of the alternatives.